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WAVELENGTH-CONVERSION EFFICIENCY ENHANCEMENT IN NANO-TEXTURED FLUORESCENT 6H-SiC PASSIVATED BY ATOMIC LAYER DEPOSITED TITANIUM OXIDE

Weifang Lu[a], Yiyu Ou[a], Valdas Jokubavicius[b], Ahmed Fadil[a], Mikael Syväjärvi[b], Paul Michael Petersen[a], and Haiyan Ou[a]

[a] *Department of Photonics Engineering, Technical University of Denmark, DK-2800, Lyngby, Denmark, weilu@fotonik.dtu.dk*

[b] *Department of Physics, Chemistry and Biology, Linköping University, SE-58183, Linköping, Sweden*

In the state-of-the-art technologies, nano-textured surface is an effective approach to boost wavelength-conversion efficiency in fluorescent 6H-SiC based white light-emitting diodes (LEDs) [1]. Surface nanostructures can enhance the light emission in a broad spectral range and omnidirections compared with as-grown 6H-SiC [2]. However, the surface recombination needs to be suppressed to further improve the conversion efficiency. Up to now, still very little work has been reported on surface passivation of fluorescent 6H-SiC. The atomic layer deposited (ALD) TiO_2 thin film has been reported to passivate the Si based solar cells [3]. In this work, we investigate the surface passivation effect on nano-textured fluorescent 6H-SiC by (ALD) TiO_2 thin films.

Nitrogen and boron co-doped 6H-SiC epilayers (100 μm) were grown on 1.4° off-axis 6H-SiC substrate by the Fast Sublimation Growth Process (FSGP) [4]. Based on the self-assembled nano-patterned reactive-ion etching (RIE) method [5], nano-textured surfaces were fabricated on three samples (a, b, c). Prior to TiO_2 film deposition, sample b and c were cleaned by oxygen plasma and dilute HF for 15min and 5min, respectively. A 20nm thick layer was deposited on sample b and c by thermal ALD (Picosun R200). The TiO_2 films were synthesized using titanium tetrachloride ($TiCl_4$) and H_2O gas as precursors. The deposition was performed at 300°C with a growth rate of 0.4Å per cycle. After TiO_2 deposition, sample c was annealed at 500°C for an hour in N_2 atmosphere.

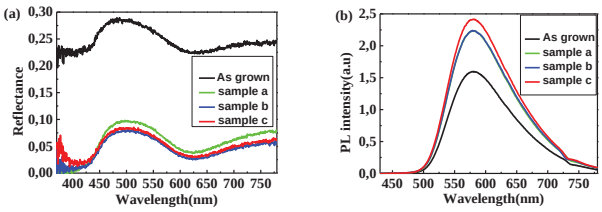

Fig. 1. (a) Reflectance and (b) photoluminescence spectra of as-grown sample, sample a (nano-textured), sample b (covered with 20nm thick TiO_2) and sample c (covered with 20nm thick TiO_2 and annealed at 500°C for 1h).

The reflectance of sample b and c covered with 20nm thick TiO_2 slightly decreases compared to sample a, as shown in Fig. 1(a). After deposition of 20nm thick TiO_2 layer, the photoluminescence (PL) intensity remains the same. However, the annealed sample c has stronger photoluminescence than the other samples, i.e. the PL has been improved by 8.05% compared to sample b, as shown in Fig. 1(b).

Our experiments show that TiO_2 film has an efficient passivation effect on nano-textured fluorescent 6H-SiC after the annealing. The effective passivation is likely to be further improved when the thickness of TiO_2, deposition conditions of TiO_2 and the annealing conditions.

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